REMARKS

Claims 1, 4, and 15 have been amended. Claims 1 through 20 remain in the application.

Claims 1 through 20 were rejected under 35 U.S.C. § 103 as being unpatentable over Zilles et al. (U.S. Patent No. 6,111,577). Applicants respectfully traverse this rejection.

As to patentability, 35 U.S.C. § 103 provides that a patent may not be obtained:

> If the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Id.

The United States Supreme Court interpreted the standard for 35 U.S.C. § 103 in Graham v. John Deere, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). In Graham, the Court stated that under 35 U.S.C. § 103:

> The scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or non-obviousness of the subject matter is determined. 148 U.S.P.Q. at 467.

Using the standard set forth in Graham, the scope and content of the prior art relied upon by the Examiner will be determined.

As to the scope and content of the art, U.S. Patent No. 6,111,577 to Zilles et al. discloses a method and apparatus for determining forces to be applied to a user through a haptic interface. FIG. 15 shows an embodiment of an apparatus for determining forces to be applied to a user through a haptic interface. The apparatus includes a sensor 140, a haptic rendering processor 142 for determining the forces to be applied to the user, a display processor 144, a

force actuator 148, and a display 150. The purpose of the sensor 140 is to sense the position of the user 146. The haptic rendering processor 142 is in electrical communication with the sensor 140 and executes an algorithm to determine the forces to be applied to the user 146 in real space. The algorithm includes a module generating a representation of a real world object in graphic space, a module determining the user's haptic interface in graphic space, a module determining the user's fiducial object in graphic space, and a module calculating a force to be applied to the user in real space. The module determining the user's haptic interface in graphic space translates the position of the user in real space into a position in graphic space. The module determining the user's fiducial object in graphic space determines the location at which the haptic interface would be if the haptic interface could be prevented from penetrating virtual objects. In one embodiment, the user's haptic interface and fiducial object are points in graphic space. In one embodiment, the module calculating a force to be applied to the user in real space calculates a stiffness force to be applied to the user. The display processor 144 is in electrical communication with the haptic rendering processor 142. The display processor 144 displays, the representation of the real world object created by the haptic rendering processor 142 on a display 150. In one embodiment, the display processor 144 also displays the user's fiducial object location on the display 150. The user's fiducial object location represents the position of the user in graphic space relative to the virtual object. The force actuator 148 is in electrical communication with the haptic rendering processor 142. The force actuator 148 produces the force calculated by the haptic rendering processor 142 and applies the calculated force to the user 146. Zilles et al. does not disclose a stick-to-surface force and a property-feedback force being determined and applied to a haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model.

In contradistinction, claim 1, as amended, clarifies the invention claimed as a system of interactive evaluation of a geometric model including a computer system having a memory, a processor, a user input device, and a display device. The system also includes a computer generated geometric model stored in the memory of the computer system. The system further includes a haptic interface operatively in communication with the computer system. The haptic interface includes a haptic device for transmitting information between a user and the geometric model. A haptic device position and orientation are acquired with respect to a surface of the geometric model and mapped into a geometric model coordinate reference system. A closest point position and orientation on the surface of the geometric model to the haptic device position is determined. A surface property of the geometric model at the closest point position and orientation is extracted. A stick-to-surface force and a property-feedback force are determined and applied to the haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model.

The United States Court of Appeals for the Federal Circuit (CAFC) has stated in determining the propriety of a rejection under 35 U.S.C. § 103, it is well settled that the obviousness of an invention cannot be established by combining the teachings of the prior art absent some teaching, suggestion or incentive supporting the combination. See In re Fine, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988); Ashland Oil, Inc. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 227 U.S.P.Q. 657 (Fed. Cir. 1985); ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 221 U.S.P.Q. 929 (Fed. Cir. 1984). The law followed by our court of review and the Board of Patent Appeals and Interferences is that "[a] prima facie case of obviousness is established when the teachings from the prior art itself would appear to have suggested the claimed subject matter to a person of ordinary skill in the art." In re Rinehart, 531

F.2d 1048, 1051, 189 U.S.P.Q. 143, 147 (C.C.P.A. 1976). See also In re Lalu, 747 F.2d 703, 705, 223 U.S.P.Q. 1257, 1258 (Fed. Cir. 1984) ("In determining whether a case of prima facie obviousness exists, it is necessary to ascertain whether the prior art teachings would appear to be sufficient to one of ordinary skill in the art to suggest making the claimed substitution or other modification.")

As to the differences between the art and the claims at issue, Zilles et al. '577 merely discloses a method and apparatus for determining forces to be applied to a user through a haptic interface having a sensor, a haptic rendering processor for determining the forces to be applied to the user, a display processor, a force actuator, and a display. Zilles et al. '577 lacks a stick-to-surface force and a property-feedback force being determined and applied to a haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model.

As to the level of ordinary skill in the pertinent art, in Zilles et al. '577, the stiffness force represents a force that would be applied to a user in a real world by a real world object due to a stiffness of a surface of the object (See Col. 6, lines 49 through 51). However, there is absolutely no teaching of a level of skill in the virtual reality art to include a stick-to-surface force and a property-feedback force being determined and applied to a haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model. The Examiner may not, because she doubts that the invention is patentable, resort to speculation, unfounded assumptions or hindsight reconstruction to supply deficiencies in the factual basis. See In re Warner, 379 F. 2d 1011, 154 U.S.P.Q. 173

(CCPA 1967). In Zilles et al. '577, the haptic device is never locked to the surface, but is free to move in space. As such, there is no motivation in the art to modify Zilles et al. '577.

The reference, if modifiable, fails to teach or suggest the combination of a system of interactive evaluation of a geometric model including a haptic device for transmitting information between a user and the geometric model wherein a haptic device position and orientation are acquired with respect to a surface of the geometric model and mapped into a geometric model coordinate reference system, a closest point position and orientation on the surface of the geometric model to the haptic device position is determined, a surface property of the geometric model at the closest point position and orientation is extracted, and a stick-to-surface force and a property-feedback force are determined and applied to the haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model as claimed by Applicants. The claimed invention is novel and unobvious because a system and method of interactive evaluation of a geometric model is provided that constrains a user's motion to stick to a surface of a geometric model within a virtual environment. Thus, the Examiner has failed to establish a case of prima facie obviousness. Therefore, it is respectfully submitted that claim 1 and the claims dependent therefrom are allowable over the rejection under 35 U.S.C. § 103.

As to claim 4, claim 4, as amended, clarifies the invention claimed as a method of interactive evaluation of a geometric model. The method includes the steps of acquiring a haptic device position and orientation with respect to a surface of the geometric model. The haptic device is operatively connected to a haptic interface and the geometric model is stored in a memory of a computer system. The method also includes the steps of mapping the haptic device position and orientation into a geometric model coordinate reference system. The method

includes the steps of determining a closest point position and orientation on the surface of the geometric model to the haptic device position and extracting a surface property of the geometric model at the closest point position and orientation. The method further includes the steps of determining a stick-to-surface force and a property feedback force using the surface property at the closet point position and orientation and applying the stick-to-surface force and property feedback force to control a location and force output of the haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model..

The reference, if modifiable, fails to teach or suggest the claimed invention of claim 4. Specifically, Zilles et al. '577 merely discloses a method and apparatus for determining forces to be applied to a user through a haptic interface having a sensor, a haptic rendering processor for determining the forces to be applied to the user, a display processor, a force actuator, and a display. Zilles et al. '577 lacks determining a stick-to-surface force and a property feedback force using a surface property at a closet point position and orientation and applying a stick-to-surface force and property feedback force to control a location and force output of a haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model. In Zilles et al. '577, the haptic device is never locked to the surface, but is free to move in space, and does not constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model. As such, there is no motivation in the art to modify Zilles et al. '577.

The present invention sets forth a unique and non-obvious combination of a method of interactive evaluation of a geometric model in which the motion of the user is

constrained to the virtual surface representing the geometric model, to provide the user with an enhanced understanding of the geometric properties of the model. The reference, if modifiable, fails to teach or suggest the combination of a method of interactive evaluation of a geometric model including the steps of determining a stick-to-surface force and a property feedback force using a surface property at a closet point position and orientation and applying the stick-to-surface force and property feedback force to control a location and force output of a haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model as claimed by Applicants.

Further, the CAFC has held that "[t]he mere fact that prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification". In re Gordon, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984). The Examiner has failed to show how the prior art suggested the desirability of modification to achieve Applicants' invention. Thus, the Examiner has failed to establish a case of prima facie obviousness. Therefore, it is respectfully submitted that claim 4 and the claims dependent therefrom are allowable over the rejection under 35 U.S.C. § 103.

As to claim 15, claim 15, as amended, clarifies the invention claimed as a method of interactive evaluation of a geometric model. The method includes the steps of selecting a geometric model from a database in the memory of a computer system and acquiring a haptic device position and orientation with respect to a surface of the geometric model. The haptic device is operatively connected to a haptic interface. The method also includes the steps of mapping the haptic device position and orientation into a geometric model coordinate reference system and determining a closest point position and orientation on the surface of the geometric model to the haptic device position. The method includes the steps of extracting a surface

property at the closest point position and orientation and mapping the surface property of the closest point position and orientation into a vector. The method further includes the steps of mapping the surface property of the closest point position and orientation into the haptic device coordinate reference system, determining a stick-to-surface force and a property feedback force using the surface property of the geometric model at the closet point position and orientation, and applying the stick-to-surface force and property feedback force to control a location and force output of the haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model.

None of the references cited, either alone or in combination with each other, teach or suggest the claimed invention of claim 15. Specifically, Zilles et al. '577 merely discloses a method and apparatus for determining forces to be applied to a user through a haptic interface having a sensor, a haptic rendering processor for determining the forces to be applied to the user, a display processor, a force actuator, and a display. Zilles et al. '577 lacks mapping a surface property of a closest point position and orientation into a haptic device coordinate reference system, determining a stick-to-surface force and a property feedback force using the surface property of the geometric model at the closet point position and orientation, and applying the stick-to-surface force and property feedback force to control a location and force output of the haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model. In Zilles et al. '577, the haptic device is never locked to the surface, but is free to move in space, and does not constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model. As such, there is no motivation in the art to modify Zilles et al. '577.

The reference, if modifiable, fails to teach or suggest the combination of a method of interactive evaluation of a geometric model including mapping a surface property of a closest point position and orientation into a haptic device coordinate reference system, determining a stick-to-surface force and a property feedback force using the surface property of the geometric model at the closet point position and orientation, and applying the stick-to-surface force and property feedback force to control a location and force output of the haptic device to constrain a motion of the haptic device to stick to a virtual surface representing the surface of the geometric model, thereby constraining a hand of a user to always be on the surface to enable the user to explore and feel the geometric model as claimed by Applicants. The claimed invention is novel and unobvious because, in the method of interactive evaluation of a geometric model, the motion of the user is constrained to the virtual surface representing the geometric model, to provide the user with an enhanced understanding of the geometric properties of the model. Thus, the Examiner has failed to establish a case of prima facie obviousness. Therefore, it is respectfully submitted that claim 15 and the claims dependent therefrom are allowable over the rejection under 35 U.S.C. § 103.

Obviousness under § 103 is a legal conclusion based on factual evidence (In re Fine, 837 F.2d 1071, 1073, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988), and the subjective opinion of the Examiner as to what is or is not obvious, without evidence in support thereof, does not suffice. Since the Examiner has not provided a sufficient factual basis, which is supportive of his/her position (see In re Warner, 379 F.2d 1011, 1017, 154 U.S.P.Q. 173, 178 (C.C.P.A. 1967), cert. denied, 389 U.S. 1057 (1968)), the rejection of claims 1 through 20 is improper. Therefore, it is respectfully submitted that claims 1 through 20 are allowable over the rejection under 35 U.S.C. § 103.

Based on the above, it is respectfully submitted that the claims are in a condition for allowance or in better form for appeal. Applicants respectfully request reconsideration of the claims and withdrawal of the final rejection. It is respectfully requested that this Amendment be entered under 37 C.F.R. 1.116.

Respectfully submitted,

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